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NASJRB WILLOW GROVE  
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TECHNICAL MEMORANDUM PERFLUORINATED COMPOUNDS SOIL AND  
GROUNDWATER INVESTIGATION 19 MARCH 2015 THROUGH 31 MAY 2015  
SHENANDOAH WOODS HOUSING COMPLEX NAWC WARMINSTER NASJRB WILLOW  
GROVE PA  
04/01/2016  
RESOLUTION CONSULTANTS



**Technical Memorandum**  
**Perfluorinated Compounds Soil and Groundwater Investigation**  
**Shenandoah Woods Housing Complex**  
**Naval Air Warfare Center, Warminster, Pennsylvania**  
**19 March 2015 through 31 May 2015**

## **1.0 INTRODUCTION**

This Technical Memorandum summarizes the findings of a soil and groundwater investigation performed by Resolution Consultants (Resolution) at the Shenandoah Woods Housing Complex, located at the former Naval Air Warfare Center (NAWC) Warminster between 19 March 2015 and 31 May 2015, under Naval Facilities Engineering Command (NAVFAC) Atlantic, Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract No. N62470-11-D-8013, Contract Task Order (CTO) WE 28.

The former NAWC Warminster is an 824-acre facility located in Warminster Township, Northampton Township, and Ivyland Borough, Bucks County, PA. As a result of the Defense Base Realignment and Closure Act (BRAC), NAWC Warminster was closed on 31 March 1997; the entire the property, except for the Shenandoah Woods parcel, has been transferred to the private sector for redevelopment. Custody of the Shenandoah Woods Housing Complex on the NAWC Warminster property was transferred to NASJRB Willow Grove located in nearby Horsham Township, Montgomery County, Pennsylvania. Historic waste disposal locations were grouped within three general areas on the former NAWC property (see Figure 1): Area A (Sites 1, 2, and 3), Area B (Sites 5, 6, and 7), and Area C (Sites 4 and 8). A fourth general area (Area D) primarily includes the former main building complex at the former NAWC Warminster. This perfluorinated compounds (PFCs) investigation focused on the former Navy housing area, consisting of approximately 55 acres, which includes a portion of Site 5 of Area B.

PFCs are persistent in the environment and are an emerging class of environmental contaminants. PFCs are used to make a wide range of products including oil-, stain-, heat-, and water-resistant materials such as clothing (i.e. GORE-TEX®), carpeting (i.e. Scotchguard™), furniture, food packaging (i.e. popcorn bags), flooring (i.e. Stainmaster™), non-stick cookware (i.e. Teflon®), stain/water resistant paint, and roofing materials. They were also used as surfactants in metal plating baths, shampoos, moisturizers, shaving cream, oil well surfactants, aqueous film forming foam (AFFF), and semiconductor baths. Additional applications of PFCs include use in rust inhibitors, starting materials for herbicides/pesticides, acid mist suppressants, aviation hydraulic fluids, and adhesives. (Tetra Tech 2014).

Short-term Preliminary Health Advisories (PHA) were developed by the USEPA for perfluorooctanesulfonic acid (PFOS) (0.2 micrograms per liter (µg/L)) and perfluorooctanoic acid (PFOA) (0.4 µg/L) to reduce potential exposure through drinking water (EPA 2009 and 2014). Currently, there are not PHAs for the remaining four PFCs (perfluorononanoic acid [PFNA], perfluorohexanesulfonic acid [PFHxS], perfluoroheptanoic acid [PFHpA] and perfluorobutanesulfonic acid [PFBS]) evaluated during this study. The PHAs for PFOS and PFOA are not directly applicable to soil.

PFCs (PFOA and PFOS) were identified in on-site and off-site wells in the vicinity of NAWC Area C during the five year review (Tetra Tech 2011). This investigation was initiated at Shenandoah Woods in 2015 to support property transfer by characterizing the occurrence and concentrations of six PFCs: PFOA, PFOS, PFNA, PFHxS, PFHpA and PFBS, in soil and groundwater. During this investigation, eight soil samples and one blind duplicate were collected from four boring locations and groundwater samples were collected from six monitoring wells with one blind duplicate. Groundwater data for PFOS and PFOA were compared to the PHAs. PFC sample locations are shown on Figures 1 and 2.

## 2.0 FIELD ACTIVITIES

As part of this investigation, soil borings were advanced and three dual-nested monitoring well pairs were installed in the Shenandoah Woods parcel. On 19 March 2015, a geophysical survey was performed by PULS, Inc. of Bethlehem, PA under Resolution oversight for utility clearance purposes in each of the proposed boring and monitoring well locations.

### Soil Borings

On 23 March and 24 March 2015, two soil borings (SB01 and SB02) were advanced using direct push technology to 5.5 feet below ground surface (bgs) and four soil samples, one blind duplicate, and one matrix spike/matrix duplicate were collected from the boring sidewall from depths between 0.5 feet bgs to 3 feet bgs. Soil samples were collected above perched groundwater encountered at approximately 3.5 feet bgs.

Soil borings were advanced at two of the nested monitoring well locations. Four soil samples were collected from the sidewall of two monitoring wells (HN-107 and HN-109). Soil samples were collected at depths ranging from 0.8 feet bgs to 8 feet bgs.

### Monitoring Well Installation

Dual nested monitoring well pair locations were selected hydraulically down-gradient of Sites 5, 6, and 7. Well installation details are summarized below.

On 23 March through 27 March 2015, the initial boreholes were advanced at the HN-107, HN-108, and HN-109 locations (**Figure 2**). The boreholes were advanced by Raab Drilling of Perkasi, PA, a Pennsylvania-licensed driller, using an air rotary drill rig, under oversight of a Resolution geologist. Based on previous investigations at the Site, the target depths for shallow monitoring wells were approximately 50 feet below ground surface (bgs) and 100 feet bgs for the intermediate monitoring wells. At each location, a 10-inch carbide hammer was used to advance borings to 20 feet bgs and 10-inch steel outer casing was installed. Borings were advanced through the outer casing to the maximum depth of 100 feet bgs using an 8-inch carbide hammer. Two flush mounted, 2-inch diameter monitoring wells were completed at each location. Monitoring wells were constructed with 2-inch polyvinyl chloride (PVC) well screen and riser. The annular space was filled with Number 1 sand to two feet above the well screen. Filter pack material was used under the sump cap (minimum of 6 inches). To seal the annular space between the shallow and intermediate wells, a five foot thick (minimum) hydrated bentonite plug was installed above the filter pack and the monitoring well was sealed above the shallow screen using bentonite slurry via pressure grout injection to 0.5 feet bgs. The well seal cured for 24 hours prior to surface completion of the well pad. After 24 hours, no loss of annular space grout to the formation was observed. A 10-inch diameter man-hole cover was installed within a 2 foot by 2 foot concrete pad at each well location.

Monitoring wells were developed on 2 April 2015. Soil cuttings and groundwater generated during drilling were captured by an in-line containment system. Soil cuttings were containerized in a roll-off and groundwater generated during drilling and well development purge water were containerized in drums. The roll-off and drums were transported to the NAWC groundwater treatment plant. The roll off was removed for disposal, the drums were removed for off site disposal on 23 July 2015.

Completed monitoring wells were surveyed in Pennsylvania South State Plane, UTM Zones 17 and 18, by R.L. Showalter & Associates of Chalfont, PA. A Well Construction Table is provided as **Table 1**. Well construction details are summarized in **Table 1** and the well locations are shown in **Figures 1 and 2**. Boring logs and well construction diagrams are included in **Attachment 1**.

## Groundwater Sampling

On 16 April 2015, monitoring wells were gauged and sampled in accordance with EPA Region 1 Low-Stress Sampling Guidance (EPA 2010). Precautions were taken to avoid sample contamination and/or bias during collection per the draft Sampling and Analysis Plan (SAP) (Battelle 2015). Products containing Teflon<sup>®</sup> were not used during sample collection, handling, or transportation. Sampling personnel did not use any waterproof items, wore only well-laundered clothing, and attempted to identify and isolate any potential PFC-containing materials that might cross-contaminate groundwater samples.

During gauging, depth to groundwater was measured above the well screens in all six monitoring wells. Well screen intervals were selected based on where saturated conditions and/or fractures were encountered during drilling. During drilling, weathered bedrock was noted in the upper 55 to 77 feet of the boring, which gradually transitioned into competent Stockton Formation bedrock. This is consistent with a geophysical investigation designed to investigate bedrock water-bearing fractures beneath the site at Area C (U.S. Geological Survey 2008). Area C was divided by the U.S. Geological Survey into shallow and deep hydrogeologic units. The shallow unit is comprised of sandstone. The deep hydrogeologic unit is defined as water-bearing bedrock beneath the shallow hydrogeologic unit, and typically exhibits artesian conditions (Batelle 2015). Consistent with Area C, lithologic boring data and the depths groundwater was encountered in monitoring wells HN-107 S/I, HN-108 S/I, and HN-109 S/I suggest confined to semi confined conditions. Generally, the lithology identified was highly weathered from the surface until approximately 55 to 77 feet bgs. Finer grained materials (siltstone and mudstone) were identified above the more permeable sandstone units and fractures.

Groundwater was purged using dedicated, high-density, polyethylene tubing that was discarded after each sample was collected. Groundwater was extracted using a stainless steel submersible pump that was decontaminated before each use with distilled water and Alconox detergent. Monitoring wells were purged continuously until water quality parameters (pH, conductivity, dissolved oxygen, and turbidity) stabilized. Once parameters stabilized, groundwater samples were collected for analysis in clean, laboratory-supplied, PFC-free, high-density polyethylene bottles. A blind duplicate and a field blank were collected using laboratory-certified, PFC-free, deionized water. Matrix spike and matrix spike duplicate samples were collected and analyzed at a rate of one per 20 samples. Samples were packaged with ice in a cooler, and shipped via laboratory courier under chain-of-custody to Accutest Laboratories of Orlando, Florida (**Attachment 2**). Samples were analyzed for PFCs using EPA Method 537 modified for environmental media. Data validation was completed by the Resolution Project Chemist. The data were found to be valid as reported and suitable for decision-making purposes. The data validation report is provided in this document as **Attachment 3**.

## 3.0 RESULTS

There are no screening levels for PFCs in soil, however, constituents of interest were not detected above the laboratory detection limits in soil samples with the exception of SB7. The sample collected from SB7 at 0.5 feet bgs had an estimated (J) PFOS concentration (6.040 J  $\mu\text{g/kg}$ ). The concentration of PFOS in the accompanying blind duplicate of SB7 was below the detection limit for all analytes. Analytical results from eight of the nine soil samples collected during this investigation were below reporting limits for all six PFC analytes. Analytical results from the soil investigation are summarized in **Table 2**.

Concentrations of PFOS and PFOA in the groundwater samples collected on 16 April 2015 were below their respective EPA PHA in all monitoring wells sampled except PFOS in HN-108I. PFOS detected in the groundwater samples collected from HN-108I (0.236  $\mu\text{g/L}$ ) exceeded the PHA for PFOS (0.2  $\mu\text{g/L}$ ). Detectable concentrations of PFOS and PFOA were reported in all groundwater samples collected except in those obtained from HN-108S.



Concentrations of PFOA were higher than PFOS in all samples collected except HN-108I. The highest concentration of PFOA was detected in monitoring well HN-109I (0.0718 µg/L), which is below the PHA of 0.4 µg/L. The most common detection of the four additional analyzed PFCs without PHAs was PFHxS, which was reported in all of the groundwater samples. The highest concentration of PFHxS was detected in monitoring well HN-108I (0.134 µg/L). The concentration of all analytes were below their respective detection limits in all field blanks, collected each day of sampling. Analytical results from the groundwater investigation are summarized in **Table 3**.

## 4.0 REFERENCES

Battelle. 2015. Final Sampling and Analysis (SAP) Plan. October.

Department of Defense (DOD). 2011. Internal Navy Correspondence on Perfluorinated Compounds Clarification.

Tetra Tech. 2014. Evaluation of Potential Sources of Perfluorinated Compounds, Former Naval Warfare Center Warminster, Pennsylvania.

— 2011. Third Five-Year Report, Former Naval Air Warfare Center, Warminster, Pennsylvania.

United States Environmental Protection Agency (US EPA). 2009. Provisional Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS).

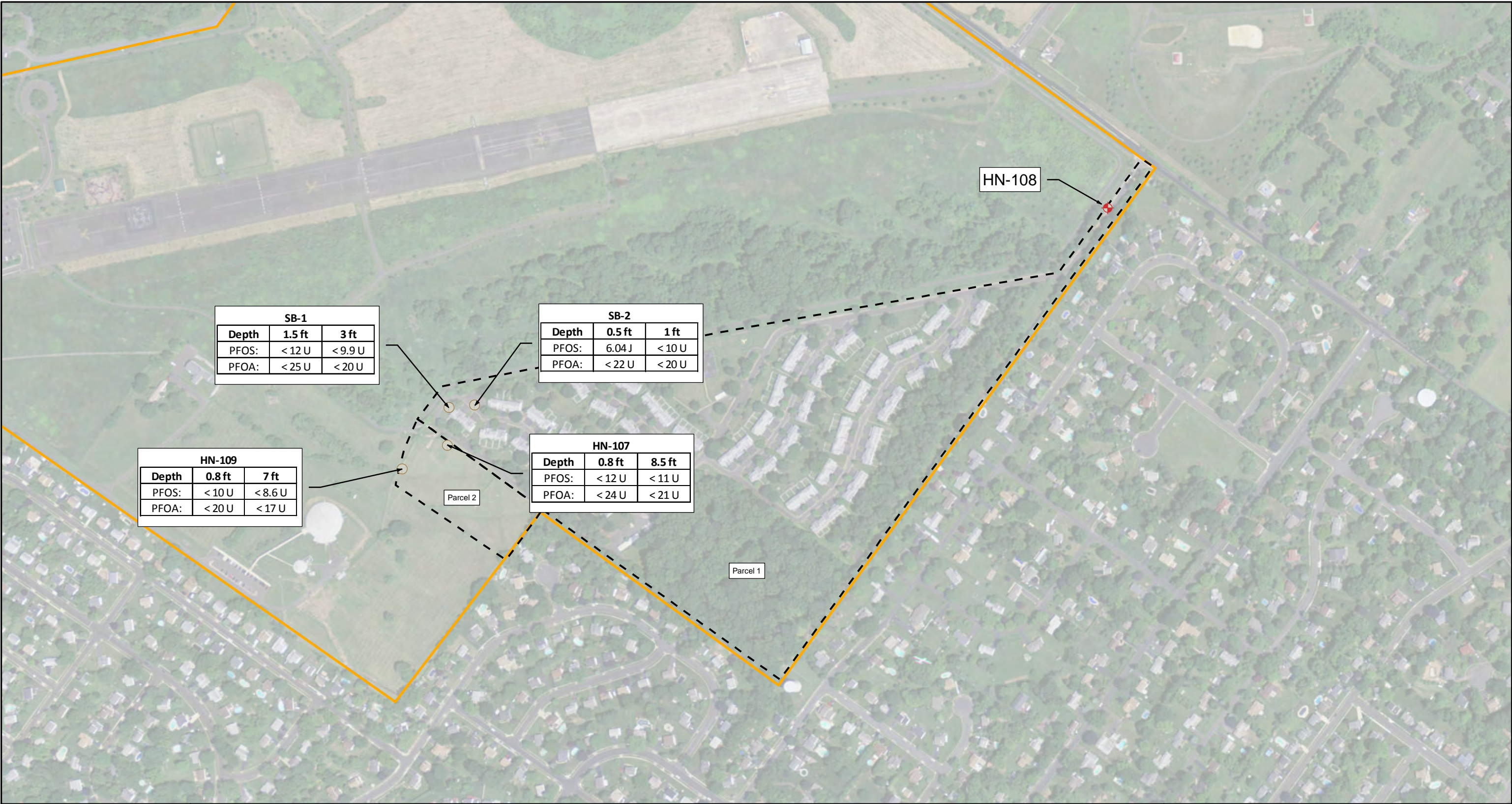
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— 2014. Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Fact Sheet.

United States Geological Survey (USGS). 2008. Interpretation of Borehole Geophysical Logs at Area C, Former Naval Air Warfare Center, Warminster Township, Bucks County, Pennsylvania, 2007. Open-File Report 2008-1207.

## FIGURES





SB-1		
Depth	1.5 ft	3 ft
PFOS:	< 12 U	< 9.9 U
PFOA:	< 25 U	< 20 U

SB-2		
Depth	0.5 ft	1 ft
PFOS:	6.04 J	< 10 U
PFOA:	< 22 U	< 20 U

HN-109		
Depth	0.8 ft	7 ft
PFOS:	< 10 U	< 8.6 U
PFOA:	< 20 U	< 17 U

HN-107		
Depth	0.8 ft	8.5 ft
PFOS:	< 12 U	< 11 U
PFOA:	< 24 U	< 21 U

Drawn: BC 8/6/2015

Approved: PJ 8/6/2015

Project #: 60276503

Map Location

Legend

- Soil Boring
- Monitoring Well
- Naval Air Warfare Center (NAWC) Site Boundary
- Site Parcel Boundaries

Notes:

PFOS/PFOA results reported in micrograms per kilogram (µg/kg)  
**PFOS** - Perfluorooctanesulfonic acid, **PFOA** - Perfluorooctanoic acid  
J - Estimated Concentration  
U - Indicates not detected above reporting detection limit  
ft - Feet

Scale in Feet

0 200 400 800

N

FIGURE 1

SOIL SAMPLE RESULTS

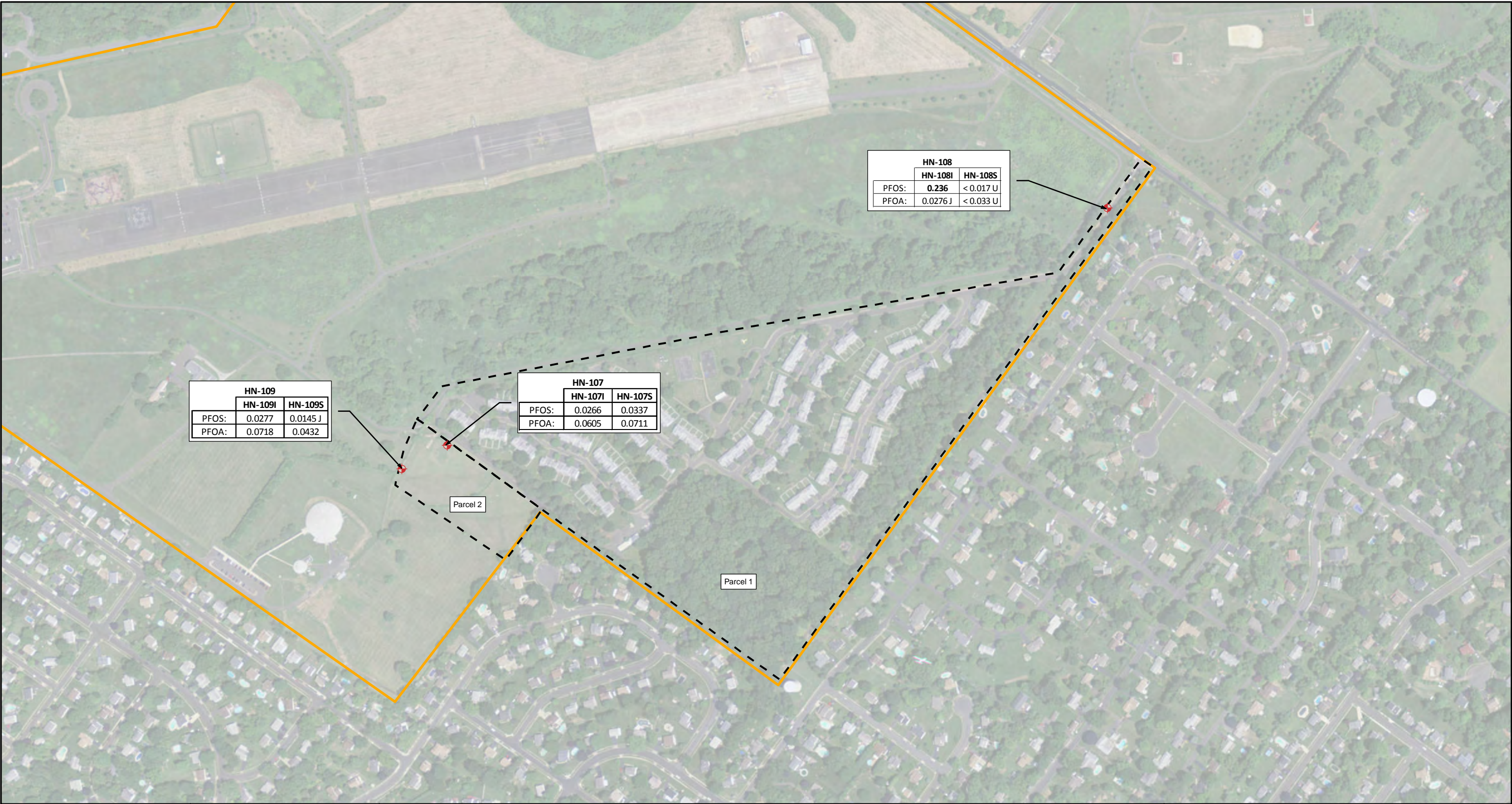
MARCH 2015

SHENANDOAH WOODS

NAWC WARMINSTER

BUCKS COUNTY, PENNSYLVANIA





Map Location

**Legend**

- Monitoring Wells
- Naval Air Warfare Center (NAWC) Site Boundary
- Site Parcel Boundaries

Notes:

PFOS/PFOA results reported in micrograms per liter (µg/L)

PFOS - Perfluorooctanesulfonic acid, PFOA - Perfluorooctanoic acid

J - Estimated Concentration

U - Indicates not detected above reporting detection limit

ft - Feet

USEPA Preliminary Health Advisory Levels

PFOS - 0.2 µg/L, PFOA - 0.4 µg/L

Scale in Feet

**FIGURE 2**

**GROUNDWATER RESULTS**

**APRIL 2015**

**SHENANDOAH WOODS**

**NAWC WARMINSTER**

**BUCKS COUNTY, PENNSYLVANIA**



## TABLES

Table 1  
Well Construction Summary  
NAWC Warminster

Well	Total Depth (ft bgs)	Screened interval (ft)	Elevation (ft amsl)	Mount	Installed
HN-107S	65	45-65	346.42	Flush	Mar-15
HN-107I	100	90-100	346.43		
HN-108S	65	45-65	380.08	Flush	Mar-15
HN-108I	100	90-100	379.98		
HN-109S	32	22-32	347.35	Flush	Mar-15
HN-109I	85	75-85	347.37		

ft bgs feet below ground surface

ft msl feet above mean sea level

Table 2  
PFC Investigation - April 2015  
Validated Results Summary  
NAWC Warminster - Shenandoah Woods

NAWC Warminster - Shenandoah Woods			Sample ID	S1-0.8_03232015	S2-0.8_03232015	S-DUP_03242015	S3-1.5_03232015	S4-8.5_03232015	S5-1.0_03232015	S6-7_03242015	S7-0.5_03242015	S8-3_03242015
			Sample Location	HN-107 - 0.8 ft	HN-109 - 0.8 ft	SB-2	SB-1 - 1.5 ft	SB-1 - 8.5 ft	SB-2 - 1.0 ft	HN-107 - 7 ft	SB-2 - 0.5 ft	SB-1 - 3 ft
			Sample Date	3/23/2015	3/23/2015	3/24/2015	3/23/2015	3/23/2015	3/23/2015	3/24/2015	3/24/2015	3/24/2015
			Sampled Delivery Group	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101
Chemical Name	CAS	Units										
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/Kg	< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/Kg	< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/Kg	< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U	
Perfluorononanoic Acid (PFNA)	375-95-1	µg/Kg	< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/Kg	< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	6.04 J	< 9.9 U	
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/Kg	< 24 U	< 20 U	< 22 U	< 25 U	< 21 U	< 20 U	< 17 U	< 22 U	< 20 U	

			Sample ID	EB-032315	FB-032315	FB-032415
			Sample Date	3/23/2015	3/23/2015	3/24/2015
			Sampled Delivery Group	FA23101	FA23101	FA23101
Chemical Name	CAS	Units				
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	< 0.015 U	< 0.016 U	< 0.015 U	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	< 0.015 U	< 0.016 U	< 0.015 U	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	< 0.015 U	< 0.016 U	< 0.015 U	
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	< 0.015 U	< 0.016 U	< 0.015 U	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	< 0.015 U	< 0.016 U	< 0.015 U	
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	< 0.031 U	< 0.032 U	< 0.031 U	

Notes:  
CAS Chemical Abstracts Service Number  
U indicates not detected above reporting detection limit  
J indicates estimated value  
ft feet  
µg/Kg micrograms per kilogram  
µg/L micrograms per liter



Table 3  
PFC Investigation - April 2015  
Validated Results Summary  
NAWC Warminster - Shenandoah Woods

Sample ID Location Screen Interval Sample Date Sampled Delivery Group				HN-107I_04162015 HN-107I 90-100 4/16/2015 FA23700	HN-107S_04162015 HN-107S 45-65 4/16/2015 FA23700	HN-108I_04172015 HN-108I 90-100 4/17/2015 FA23700	HN-108S_04172015 HN-108S 45-65 4/17/2015 FA23700
Chemical Name	CAS	Units	EPA Health Advisory Level				
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	NA	< 0.015 U	< 0.015 U	0.0353	0.0664
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	NA	< 0.015 U	0.00862 J	0.0259	< 0.017 U
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	NA	0.0398	0.0444	0.134	0.0131 J
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	NA	< 0.015 U	< 0.015 U	< 0.015 U	< 0.017 U
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	0.2	0.0266	0.0337	0.236	< 0.017 U
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	0.4	0.0605	0.0711	0.0276 J	< 0.033 U

Sample ID Location Screen Interval Sample Date Sampled Delivery Group				HN-109S_04162015 HN-109S 22-32 4/16/2015 FA23700	DUP-041615 HN-109S 22-32 4/16/2015 FA23700	HN-109I_04162015 HN-109I 75-85 4/16/2015 FA23700	FB-041615 4/16/2015 FA23700	FB-041715 4/17/2015 FA23700
Chemical Name	CAS	Units	EPA Health Advisory Level					
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	NA	0.0413	0.0414	0.0448	< 0.016 U	< 0.015 U
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	NA	< 0.017 U	< 0.016 U	< 0.017 U	< 0.016 U	< 0.015 U
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	NA	0.0275	0.0262	0.0494	< 0.016 U	< 0.015 U
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	NA	< 0.017 U	< 0.016 U	< 0.017 U	< 0.016 U	< 0.015 U
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	0.2	0.0145 J	0.0134 J	0.0277	< 0.016 U	< 0.015 U
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	0.4	0.0432	0.0412	0.0718	< 0.032 U	< 0.031 U

Notes:  
CAS Chemical Abstracts Service Number  
U indicates not detected above reporting detection limit  
J indicates estimate value  
EPA Environmental Protection Agency  
Gray shading indicate exceedance of EPA Health Advisory Level  
µg/L micrograms per liter  
Screen Interval is expressed in feet below ground surface

**ATTACHMENT 1**

		Client: Department of the Navy					Boring: <b>HN-107S/I</b>				
		Project Number: 60276503									
		Site Location: NAWC Warminster, PA									
		Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43					Sheet: 1 of 5				
		Drilling Method: Air Rotary/Percussion					Well Installed: Dual nested				
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100					
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 346.7		Date Complete: 3/27/2015		Water level: 1 ft./56 ft./76 ft.					
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details		
1	S1	Not Applicable	Not Applicable	0.0		CL	Cleared to 5 ft. bgs. via vacuum truck and hand auger.	Concrete			
2							0 to 4.5 ft. bgs.: SILTY CLAY with GRAVEL (CL); brown and dark brown; clay (85%); sand and gravel (5-10%), angular; trace silt; high plasticity; soft; septic odor; debris (plastic and cement); wet to saturated at 1.2 ft.				
3							<b>S1-0.8 collected 1143</b>				
4											
5											
6		6	10%	0.0		Silt-stone	5 to 7 ft. bgs.: SILTSTONE (Stockton Fm.); dark reddish-brown; decomposed/intensely weathered; soft; saturated.	2 in. PVC riser			
7		12									
8		18									
9	S4	15	80%	0.0		Silt-stone	7 to 9 ft. bgs.: SILTSTONE (Stockton Fm.); reddish-brown; intensely weathered; soft; iron oxide banding and lamination; micaceous; bottom 4 in. competent sandstone; saturated to 8 ft. grading to dry.			Hydrated bentonite grout	
10		17									
11		22									
12		24		NR		<b>S4-8.5 collected 1340</b>					
13		Not Applicable				Silt-stone	15 ft. bgs.: SILTSTONE (Stockton Fm.); dull reddish-brown; moderately to slightly weathered; dry.	10 in. Steel casing end			
14											
15											
16											
17											
18											
19											
20										20 ft. bgs.: Same as above; dry.	

		Client: Department of the Navy				Boring: <b>HN-107S/I</b>			
		Project Number: 60276503							
		Site Location: NAWC Warminster, PA							
		Coordinates: 2751877.177 326037.182		TOC Elevation: 346.42/346.43		Sheet: 2 of 5			
		Drilling Method: Air Rotary/Percussion				Well Installed: Dual nested			
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100			
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 346.7		Date Complete: 3/27/2015		Water level: 1 ft./56 ft./76 ft.			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21						Silt-stone	10 in. steel casing set at 20 ft. bgs. Boring diameter reduced to 8.25 in.		
22									
23							23 ft. bgs.: Same as above; dry.		
24									
25						SS	25 ft bgs.: SANDSTONE (Stockton Fm.); gray; fine-grained; moderately weathered to fresh; hard; micaceous; dry.		
26									
27							27 ft. bgs.: Same as above, argillaceous SILTSTONE (Stockton Fm.); moderately weathered; dry.	Hydrated bentonite grout	
28						SS/ Silt-stone			
29									
30									
31								2 in. PVC riser	
32									
33									
34						SS			
35							35 ft. bgs.: SANDSTONE (Stockton Fm.); buff/tan; fine-grained; moderately hard; fresh to moderately weathered; dry.		35 ft.
36									
37									
38								Hydrated bentonite 1/2 in. TR30	
39						SS			
40							40 ft. bgs.: Same as above; dry.		



							Client: Department of the Navy		Boring: <b>HN-107S/I</b>	
							Project Number: 60276503			
							Site Location: NAWC Warminster, PA			
							Coordinates: 2751877.177    326037.182    TOC Elevation: 346.42/346.43		Sheet: 3 of 5	
Drilling Method: Air Rotary/Percussion		Well Installed: Dual nested								
Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.		Screen: 45-65/90-100						
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100				
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 346.7		Date Complete: 3/27/2015		Water level: 1 ft./56 ft./76 ft.				
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details	
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60						SS	45 ft. bgs.: SILTY SANDSTONE (Stockton Fm.); tan; fine-grained; moderately hard; moderately weathered; dry to slightly wet.	Hydrated bentonite 1/2 in. TR30		
						SS	51 ft. bgs.: Same as above; wet.	#1 Silica sand		
							54 ft. bgs.: Same as above; dry to slightly wet.	0.01 in. slotted screen		
						Silt-stone	Use air from drill rig to blow out boring. Very little water.  54 to 56 ft. bgs.: SILTSTONE (Stockton Fm.); dry, becoming saturated at 56 ft.	2 in. PVC riser		

<div><div>Location Sketch</div><div><div>North</div><div>Duplexes</div></div><div><div>⊗</div><div>HN-107S/I</div></div></div>							Client: Department of the Navy			Boring: <b>HN-107S/I</b>	
							Project Number: 60276503				
							Site Location: NAWC Warminster, PA				
							Coordinates: 2751877.177 326037.182		TOC Elevation: 346.42/346.43		Sheet: 4 of 5
Drilling Method: Air Rotary/Percussion			Well Installed: Dual nested								
Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.		Screen: 45-65/90-100							
Weather: Clear 30-40's °F			Logged By: G. Richards		Start Date: 3/23/2015						
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 346.7		Date Complete: 3/27/2015						
					Depth of Boring: 100						
					Water level: 1 ft./56 ft./76 ft.						
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details		
61						SS	62 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); light gray to white; medium to coarse-grained; fractured; hard; weathered, cuttings have oxidized surfaces; saturated.	#1 Silica sand	0.01 in. Slotted screen		
62											
63											
64						Mud-stone	67 ft. bgs.: MUDSTONE/SILTSTONE (Stockton Fm.); brown; cuttings return as clay; moist.	65 ft.	67 ft.		
65											
66											
67						Silt-stone	70 ft. bgs.: MUDSTONE/SILTSTONE (Stockton Fm.); reddish-brown; cuttings return as clay; moist.	Hydrated bentonite 1/2 in. TR30			
68											
69											
70						72 ft. bgs.: SILTSTONE (Stockton Fm.); moist.	75 ft. bgs.: Same as above; reddish-brown; cuttings return as clay; wet.	2 in. PVC riser			
71											
72											
73						76 ft. bgs.: High yield fracture.					
74											
75											
76											
77											
78											
79											
80											

		Client: Department of the Navy				Boring: <b>HN-107S/I</b>	
		Project Number: 60276503					
		Site Location: NAWC Warminster, PA				Sheet: 5 of 5	
		Coordinates: 2751877.177    326037.182    TOC Elevation: 346.42/346.43		Well Installed: Dual nested			
		Drilling Method: Air Rotary/Percussion		Screen: 45-65/90-100			
Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.		Depth of Boring: 100			
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015			
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 346.7		Date Complete: 3/27/2015			
Water level: 1 ft./56 ft./76 ft.							

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
81						Silt-stone	80 ft. bgs.: SILTSTONE/MUDSTONE (Stockton Fm.); hard; cuttings return as clay.		
82									
83									
84									
85							85 ft. bgs.: Same as above.		
86									
87									
88									
89									
90						Silt-stone/ SH	90 ft. bgs.: SILTSTONE/SHALE (Stockton Fm.); dark gray; hard.		
91									
92									
93									
94									
95							95 ft. bgs.: Same as above; fracture; 6 in. drop of hammer; saturated; high yield.		
96									
97						Silt-stone/ SH			
98									
99							76 to 100 ft. bgs.: high yield.		
100							TD=100 ft. bgs. Approximately 1000 gallons of water contained.		

**Legend:**

Split spoon sample

Air rotary/ percussion

First observed groundwater

PID Photoionization detector

USCS Unified soil classification system

ppm Parts per million

ft. Feet

bgs. Below ground surface

PVC Polyvinyl chloride

TR30 Time release 30 minutes

NR No recovery

in. Inches

TD Total depth

Fm. Formation

SS Sandstone

SH Shale

TOC Top of casing

GS Ground surface

**Prepared in accordance with:**

Engineering Geology Field Manual, 2<sup>nd</sup> Edition.

D2487 Practice for Classification of Soils (USCS).

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).

CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition

<div> <div> Location Sketch <div> North </div> </div> <div> Bristol Rd. </div> <div> gate </div> <div> Orion Rd. </div> <div> HN-108S/I </div> </div>				Client: Department of the Navy Project Number: 60276503 Site Location: NAWC Warminster, PA Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98 Drilling Method: Air Rotary Sample Type(s): NA				Boring: <b>HN-108S/I</b> Sheet: 1 of 5 Well Installed: Dual nested Screen: 45-65/90-100			
Weather: Clear 30-40's °F				Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100			
Drilling Contractor: RAAB (Rick Raab)				GS Elevation: 380.25		Date Complete: 3/27/2015		Water level: 55			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details		
1		Not Applicable	Not Applicable				Cleared to 5 ft. bgs. via vacuum truck and hand auger.	Concrete	1 ft.		
2										Not logged or sampled.	
3											
4											
5											
6		Not Applicable				ML	7 ft. bgs.: SILT (ML); overburden; reddish-brown; nonplastic; dense; fragments of siltstone; soft drilling; dry.	2 in. PVC riser			
7										Soil-rock contact. No transition zone of decomposed rock.	
8										10 ft. bgs.: Argillaceous SANDSTONE (Stockton Fm.); reddish-brown; fine-grained; hard; weathered, heavily oxidized; dry.	
9											
10											
11											
12											
13										13 ft. bgs.: SANDY SILTSTONE (Stockton Fm.); dull red; soft; dry.	
14											
15											
16											
17											
18										17 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); reddish-brown, fresh surface is blue-gray; medium-grained; hard; weathered, oxidized; micaceous; dry.	
19											
20										20 ft. bgs.: Same as above.	10 in. Steel casing end



<div>Location Sketch</div> <div><div>Bristol Rd.</div><div>gate</div><div>Orion Rd.</div><div>North</div><div>HN-108S/I</div></div>				Client: Department of the Navy				Boring: <b>HN-108S/I</b>	
				Project Number: 60276503					
				Site Location: NAWC Warminster, PA					
				Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98		Sheet: 2 of 5			
				Drilling Method: Air Rotary		Well Installed: Dual nested			
				Sample Type(s): NA		Boring Diameter: 10 in./8.25 in. Screen: 45-65/90-100			
Weather: Clear 30-40's °F				Logged By: G. Richards		Start Date: 3/23/2015			
Drilling Contractor: RAAB (Rick Raab)				GS Elevation: 380.25		Date Complete: 3/27/2015			
						Depth of Boring: 100			
						Water Level: 55			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21							10 in. Steel casing set at 20 ft. bgs. Boring diameter reduced to 8.25 in.		
22									
23						SS	23 ft. bgs.: SANDSTONE (Stockton Fm.); tan to light brown; very fine-grained; medium hard; cuttings return as fine dust; dry.		
24									
25									
26									
27									
28						SS	28 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); orange tan and light brown; medium to fine-grained; hard; moderately weathered; trace micas; slightly moist to dry.		
29									
30						Silt-stone	30 ft. bgs.: SILTSTONE (Stockton Fm.); dull red; soft; dry.		
31									
32									
33									
34						SS/ Silt-stone	30 to 40 ft. bgs.: Interbedded SANDSTONE and SILTSTONE (Stockton Fm.); dull red; weathered; hard; dry.		
35									
36									
37									
38									
39									
40									

Hydrated bentonite grout

2 in. PVC riser

<u>Location Sketch</u>						Client: Department of the Navy		Boring: <b>HN-108S/I</b>	
Bristol Rd.						Project Number: 60276503			
North ↗						Site Location: NAWC Warminster, PA			
gate		Orion Rd.		⊗ HN-108S/I		Coordinates: 2754686.937    327115.265    TOC Elevation: 380.08/379.98		Sheet: 3 of 5	
						Drilling Method: Air Rotary		Well Installed: Dual nested	
						Sample Type(s): NA		Screen: 45-65/90-100	
Weather: Clear 30-40's °F						Logged By: G. Richards		Start Date: 3/23/2015	
Drilling Contractor: RAAB (Rick Raab)						GS Elevation: 380.25		Date Complete: 3/27/2015	
						Depth of Boring: 100		Water Level: 55	
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
41						SS	40 ft. bgs.: SANDSTONE (Stockton Fm.); dark red; fine grained; moderate to heavily weathered; micaceous; dry.	Hydrated bentonite grout	
42						SS	45 ft. bgs.: SANDSTONE (Stockton Fm.); strong brown; fine grained; hard; micaceous; fractured; slightly wet.	2 in. PVC riser	
43							47 ft. bgs.: Same as above; wet.		
44						Silt-stone	48 ft. bgs.: SILTSTONE (Stockton Fm.); wet.	48 ft. Hydrated bentonite 1/2 in. TR30	
45						Clay-stone	50 ft. bgs.: CLAYSTONE (Stockton Fm.); strong brown; wet.		
46						SS	Slightly fractured SANDSTONE above 55 ft. cuttings wet with silt/mud.		
47							55 ft. bgs: Arkosic SANDSTONE (Stockton Fm); orangish brown; medium grained; medium hard; saturated.	55 ft.	
48						SS/ Silt-stone	Interbedded SANDSTONE and SILTSTONE (Stockton Fm.); hard; cuttings return as brown sandy silt; hard drilling, slow; fractured with high yield.	0.01 in. Slotted screen	
49								#1 Silica Sand	
50									



<div style="text-align: center;"> <u>Location Sketch</u>  </div>			Client: Department of the Navy			Boring: <b>HN-108S/I</b>		
			Project Number: 60276503					
			Site Location: NAWC Warminster, PA					
			Coordinates: 2754686.937    327115.265    TOC Elevation: 380.08/379.98			Sheet: 5 of 5		
			Drilling Method: Air Rotary			Well Installed: Dual nested		
			Sample Type(s): NA			Boring Diameter: 10 in./8.25 in.		
						Screen: 45-65/90-100		
Weather: Clear 30-40's °F			Logged By: G. Richards			Start Date: 3/23/2015		
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 380.25			Date Complete: 3/27/2015		
						Depth of Boring: 100		
						Water Level: 55		

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
81						SH	81 ft. bgs.: SHALE (Stockton Fm.); dark grayish-brown; hard.	2 in. PVC riser	
82									
83									
84									
85						SS	85 ft. bgs.: SANDSTONE (Stockton Fm.); dark blue-gray; very fine-grained; hard; micaceous; saturated.		
86						Clay-stone	86 ft. bgs.: CLAYSTONE (Stockton Fm.); reddish-brown; thinly bedded.		
87						SS	87 ft. bgs.: SANDSTONE (Stockton Fm.); light-gray; fine and medium-grained; appears to be alternating thinly bedded; red SILTSTONE with blue-gray SANDSTONE; saturated.		
88									
89									
90							90 ft. bgs.: SANDSTONE (Stockton Fm.); blue-gray; fine and medium-grained; hard; saturated.		
91									
92							Hammer bouncing; competent; hard; advancing ~1ft./minute.		
93									
94									
95							95 ft. bgs.: Same as above; competent SANDSTONE (Stockton Fm.); micaceous; saturated.		
96									
97						SS/ Silt-stone	97 ft. bgs.: Interbedded SANDSTONE and thin bedded SILTSTONE (Stockton Fm.).		
98									
99									
100							TD = 100 ft. bgs.		

**Legend:**

Split spoon sample

Air rotary/percussion

First observed groundwater

PID Photoionization detector

USCS Unified soil classification system

ppm Parts per million

ft. Feet

bgs. Below ground surface

PVC Polyvinyl chloride

TR30 Time release 30 minutes

NR No recovery

in. Inches

TD Total depth

Fm. Formation

SS Sandstone

SH Shale

TOC Top of casing

GS Ground surface

**Prepared in accordance with:**

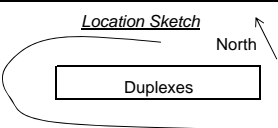

Engineering Geology Field Manual, 2<sup>nd</sup> Edition.

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D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).

CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition



							Client: Department of the Navy Project Number: 60276503 Site Location: NAWC Warminster, PA Coordinates: 2751688.399 325998.153 TOC Elevation: 347.35/347.37 Drilling Method: Air Rotary/Percussion Sample Type(s): Split Spoon Boring Diameter: 10 in./8.25 in.			Boring: <b>HN-109S/I</b> Sheet: 3 of 5 Well Installed: Dual nested Screen: 22-32/75-85		
Weather: Clear 30-40's °F Drilling Contractor: RAAB (Rick Raab)							Logged By: G. Richards GS Elevation: 347.63		Start Date: 3/23/2015 Date Complete: 3/27/2015		Depth of Boring: 100 Water Level: 2ft./18 ft./50 ft.	
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details			
41						SS/SH	40 ft. bgs.: Interbedded SANDSTONE and CLAYSTONE (Stockton Fm.); dark blue grey; hard; contains quartzite; cuttings also return as mud, nonplastic fines; little water, drying.	Hydrated bentonite 1/2 in. TR30				
42							No cuttings from 42 to 49 to 35 ft. bgs.					
43												
44												
45												
46												
47												
48												
49												
50						SS	50 ft. bgs.: SANDSTONE (Stockton Fm.); fine to medium grained; quartz rich; medium hard; saturated.					
51												
52												
53												
54												
55						SS	55 ft. bgs.: Same as above; water bearing fracture; oxidation on surfaces.					
56												
57						Clay-stone	57 ft. bgs.: CLAYSTONE (Stockton Fm.); strong brown; cuttings return as mud. Saturated.					
58							58 ft. bgs.: Fracture, small drop in hammer.					
59								2 in. PVC riser				
60												

## **ATTACHMENT 2**

# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 9/16/15  
 Project Location: Warminster, PA Weather: 50-70°F  
 Well Number: HN-107 Shallow Sampler: BK/GR

## PURGING AND SAMPLING DEVICE

Pump Type and Model: 55 Monsoon 15098 Decontamination Procedure: dist. rinse / alginate  
 Tubing Diameter and Material: 1/2" x 3/4" HDPE Well Previously Sampled: 1st sampling event

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 65.36  
 Initial Depth to Water (ft., TOC): 3.69 Screened Interval (ft., bgs): 6.5-45

## INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 55 ft

Time:		0853	0905	0915	0921	0930	0935	0940	0945	0950	0955	1000	
Purge Rate (mL/min):		—	2450	2460	300	300-450	460	250-460	350-40	420	400-450	350	
Depth to Water (ft.):		3.50	5.31	6.16	6.11	6.74	7.30	7.01	7.24	7.32	7.32	7.35	
Volume Purged (liters)		0	1 gal	3.25	5	7.2	9.5	11	12.5	14	15.75	16.5	
Parameter and Stabilization Range*		<div>pushing Q</div> <div>flushing Q</div>											
Temp. (°C)	± 3%	—	12.50	12.82	12.62	12.96	13.05	12.99	13.01	13.07	13.11	13.17	
pH	± 0.1	—	7.14	7.04	7.06	7.05	7.05	7.08	7.10	7.10	7.10	7.10	
SC (m mhos)	± 3%	—	0.767	0.767	0.768	0.768	0.768	0.768	0.768	0.767	0.761	0.769	
DO* (mg/L)	± 10 % if >1	—	16.39	14.28	13.94	13.63	12.63	12.13	11.62	11.11	10.74	10.42	
ORP (mv)	± 10 mv	—	32	-3	-8	-15	-18	-22	-25	-27	-28	-30	
Turbidity (NTU)	± 10%	—	92.3	21.7	3.8	2.5	2.4	0.8	0	0.4	0	0	
TDS <u>g/L</u>	none	—	0.491	0.491	0.492	0.491	0.491	0.492	0.491	0.491	0.491	0.492	
Color/odor	none	—	clear cloudy	clear	clear	clear	cloud	clear	clear	clear	clear	clear	
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: 1075 Sample time: 1005  
 Comments/Analytes: HN-1075 low flow/stress purging

# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 1/16/15  
 Project Location: Warminster, PA Weather: clear 60's °F  
 Well Number: HN-107 Intermediate Sampler: BK/LR

## PURGING AND SAMPLING DEVICE

Pump Type and Model: SS Monsoon 15098 Decontamination Procedure: deal rinse/ignition  
 Tubing Diameter and Material: 2" x 3/8" HDPE Well Previously Sampled: NA - 1st sample from well

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 99.10  
 Initial Depth to Water (ft., TOC): 15.89 Screened Interval (ft., bgs): 90-100 \* (89-99)

## INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 95 ft

Time:	1017	1022	1030	1035	1040	1045	1050	1055	1100			
Purge Rate (mL/min):	✓ ±250	±250	±250	±250	±250	±200	±200	±200	±200			
Depth to Water (ft.):	15.97	16.02	16.10	16.09	16.10	16.06	16.07	16.06	16.04			
Volume Purged (liters)	✓ 0.75	3.5	4	5	7.5	8	9.25	10.0				
Parameter and Stabilization Range*												
Temp. (°C)	± 3%	✓ 13.06	13.11	13.11	13.11	13.27	13.22	13.24	13.31			
pH	± 0.1	✓ 7.11	7.15	7.16	7.16	7.17	7.18	7.18	7.18			
SC (m mhos)	± 3%	✓ 0.720	0.717	0.700	0.693	0.697	0.694	0.685	0.684			
DO* (mg/L)	± 10 % if >1	✓ 3.03	2.35	2.18	1.99	1.85	1.84	1.77	1.77			
ORP (mv)	± 10 mv	✓ -31	-43	-46	-48	-51	-51	-51	-52			
Turbidity (NTU)	± 10%	✓ 404	18.0	7.7	4.1	2.0	2.0	2.1	2.1			
TDS	none	✓ 0.502	0.457	0.448	0.443	0.440	0.438	0.438	0.438			
Color/odor	none	✓ light brown	clear	clear	clear	clear	clear	clear	clear			
Time:												
Purge Rate (mL/min):												
Depth to Water (ft.):												
Parameter and Stabilization Range*												
pH (std units)	± 0.1											
Conductivity (m mhos)	± 3%											
Turbidity (NTU)	± 10%											
DO* (mg/L)	± 10 %											
Temp. (°C)	N/A											
ORP (mv)	± 10 mv											

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-107I Sample time: t = 1105

Comments/Analyses: slight color & turbidity initially clearing rapidly - Q4 DTW  
equilibrated rapidly @ low discharge volume.

# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4-17-2015  
 Project Location: Warminster, PA Weather: LT. RAIN  
 Well Number: HN-108 Shallow Sampler: BK-PL

## PURGING AND SAMPLING DEVICE

Pump Type and Model: SS MONSOON Decontamination Procedure: LIQUINON + H<sub>2</sub>O  
 Tubing Diameter and Material: 1/2" x 3/8" Well Previously Sampled: HN-109E on 4-16-15

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 65.04  
 Initial Depth to Water (ft., TOC): 28.13 Screened Interval (ft., bgs): 55-65

## INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 60'

Time:		908	913	918	923	928	933	938	943	948	953	958	
Purge Rate (mL/min):		1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	
Depth to Water (ft.):		29.95	30.01	30.56	31.01	31.76	31.95	31.97	31.99	32.00	32.01	32.02	
Volume Purged (liters)		0	1.4	2.8	4.2	5.6	7	8.4	10.1	13.2	14.7	16.2	
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	12.86	12.04	12.05	12.21	11.80	11.87	12.53	12.50	12.41	12.40	12.37	
pH	± 0.1	7.83	7.12	6.81	6.74	6.71	6.74	6.73	6.70	6.57	6.55	6.56	
SC (m mhos)	± 3%	0.197	0.226	0.227	0.231	0.244	0.263	0.277	0.276	0.246	0.240	0.238	
DO* (mg/L)	± 10 % if >1	16.12	12.86	10.23	9.44	9.77	9.54	9.55	9.56	9.54	9.54	9.54	
ORP (mv)	± 10 mv	121	156	132	179	181	180	181	189	191	190	191	
Turbidity (NTU)	± 10%	91.7	128	132	137	163	164	162	101	80.7	80.1	79.7	
TDS	none	0.128	0.147	0.148	0.150	0.159	0.180	0.181	0.176	0.157	0.156	0.155	
Color/odor	none	5 TAN	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-108S Sample time: 1000

Comments/Analytes: \_\_\_\_\_

# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4-17-2015  
 Project Location: Warminster, PA Weather: LT. RAIN  
 Well Number: HN-108 Intermediate Sampler: BK-PL

## PURGING AND SAMPLING DEVICE

Pump Type and Model: SS. MONSOON Decontamination Procedure: LIQUINOX + H<sub>2</sub>O  
 Tubing Diameter and Material: 1/2" x 3/8" Well Previously Sampled: HN-108 SHALLOW

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 100.07  
 Initial Depth to Water (ft., TOC): 37.75 Screened Interval (ft., bgs):

## INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC):

Time:	1015	1020	1025	1030	1035	1040	1045	1050	1055	1100	1105	1110
Purge Rate (mL/min):	7.250	7.250	7.250	7.250	7.250	7.250	7.250	7.250	7.250	7.250	7.250	7.250
Depth to Water (ft.):	39.76	39.75	39.75	39.78	39.76	39.75	39.74	39.78	39.69	39.61	39.69	39.68
Volume Purged (liters)	15 TAN	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear
Parameter and Stabilization Range*												
Temp. (°C)	± 3%	12.09	11.92	11.95	12.01	12.05	12.07	12.11	12.21	12.16	12.25	12.29
pH	± 0.1	6.64	6.64	6.67	6.79	6.86	6.94	6.98	7.02	7.10	7.13	7.14
SC (m mhos)	± 3%	0.176	0.501	0.501	0.477	0.450	0.430	0.419	0.409	0.403	0.395	0.392
DO* (mg/L)	± 10 % if >1	13.49	4.68	5.67	4.35	5.26	4.86	5.32	5.32	5.40	5.33	5.32
ORP (mv)	± 10 mv	187	85	76	74	72	68	65	63	60	59	58
Turbidity (NTU)	± 10%	41.4	123	72.1	25.6	19.3	13.3	6.3	4.1	3.8	0.0	0.0
TDS	none	0.176	0.320	0.321	0.310	0.293	0.280	0.273	0.266	0.262	0.255	0.294
Color/odor	none	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
Time:												
Purge Rate (mL/min):												
Depth to Water (ft.):												
Parameter and Stabilization Range*												
pH (std units)	± 0.1											
Conductivity (m mhos)	± 3%											
Turbidity (NTU)	± 10%											
DO* (mg/L)	± 10 %											
Temp. (°C)	N/A											
ORP (mv)	± 10 mv											

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-108I Sample time: 1115

Comments/Analytes:



# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 9/16/15  
 Project Location: Warminster, PA Weather: clear 60's °F  
 Well Number: HN-109 Shallow Sampler: GR/BK

## PURGING AND SAMPLING DEVICE

Pump Type and Model: 55 Monsoon Decontamination Procedure: 2nd rinse  
 Tubing Diameter and Material: 1/2" x 3/8" Well Previously Sampled: 5th sample

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 31.9  
 Initial Depth to Water (ft., TOC): 3.96 Screened Interval (ft., bgs): 22 - 32

## INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 34 ft

Time:		1230	1240	1250	1300	1310	1315	1320	1325				
Purge Rate (mL/min):		✓ 200	200	2250	2250	2200	200	200	2200				
Depth to Water (ft.):		3.68	3.75	4.13	4.11	3.99	3.96	3.95	3.91				
Volume Purged (liters)		✓	1.25	3.0	5.0	<del>6.75</del>	8.5	9.25	10				
Parameter and Stabilization Range*		6.75											
Temp. (°C)	± 3%	✓	11.33	10.27	10.25	10.50	10.67	10.69	10.75				
pH	± 0.1	✓	6.56	6.30	6.16	6.12	6.14	6.16	6.19				
SC (m mhos)	± 3%	✓	0.584	0.569	0.571	0.572	0.572	0.570	0.570				
DO* (mg/L)	± 10 % if >1	✓	17.50	16.07	15.52	14.84	14.58	14.46	14.38				
ORP (mv)	± 10 mv	✓	171	159	166	167	165	164	163				
Turbidity (NTU)	± 10%	✓	46.5	15.0	4.9	1.2	0.5	0.1	✓				
TDS	none	✓	0.372	0.365	0.365	0.366	0.366	0.365	0.365				
Color/odor	none	✓	clear	clear	clear	clear	clear	clear	clear				
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-1095 Sample time: t=1327

Comments/Analytes: \_\_\_\_\_

# GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4/16/15  
 Project Location: Warminster, PA Weather: clear 70°F  
 Well Number: HN-109 Intermediate Sampler: GR/BK

## PURGING AND SAMPLING DEVICE

Pump Type and Model: SS Monsoon Decontamination Procedure: dual rinse & alcohol  
 Tubing Diameter and Material: 1/2" x 3/8" HDPE Well Previously Sampled: NA

## WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 84.44  
 Initial Depth to Water (ft., TOC): 17.20 Screened Interval (ft., bgs): 75 to 85 (74.5 to 84.5)  
 Indicator Parameter Monitoring Pump Set at Depth (ft., TOC): 80 ft

Time:		1345	1355	1405	1410	1420	1425	1430	1435				
Purge Rate (mL/min):		✓ 4	±400	±400	±400	±400	±400	±400	±400				
Depth to Water (ft.):		17.21	17.64	17.66	17.68	17.68	17.69	17.69	17.68				
Volume Purged (liters)		✓	3.25	6.5	7.5	9.5	12	14.5					
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	✓	12.65	12.66	12.71	12.70	12.62	12.60	12.62				
pH	± 0.1	✓	7.07	7.12	7.13	7.15	7.16	7.18	7.18				
SC (m mhos)	± 3%	✓	0.723	0.716	0.713	0.712	0.712	0.711	0.718				
DO* (mg/L)	± 10 % if >1	✓	2.74	2.06	1.87	1.74	1.66	1.54	1.50				
ORP (mv)	± 10 mv	✓	-10	-17	-19	-20	-22	-23	-24				
Turbidity (NTU)	± 10%	✓	48.0	6.0	2.2	1.0	0.4	0.2	0.4				
TDS g/L	none	✓	0.462	0.458	0.457	0.456	0.456	0.455	0.455				
Color/odor	none	✓	cloudy	clear	clear	clear	clear	clear	clear				
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

\* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-109I Sample time: 7:1440

Comments/Analytes: \_\_\_\_\_



ACCUTEST<sup>®</sup>  
LABORATORIES

Chain of Custody  
4405 Vineyard Road, Suite C-15 Orlando, FL 32811  
TEL: 407-425-6700 FAX: 407-425-0707  
www.accutest.com

Accutest Laboratories Southeast

ACCUTEST JOB # :

PAGE 1 OF 1

Accutest Quote #

SKIFF #

Client / Reporting Information			Project Information		Analytical Information		Matrix Codes	
AECOM			Project Name: NAWC Warmminster		Area: B		DW - Drinking Water	
125 Rock Road			Street		State		GW - Ground Water	
Horsham, PA 19044			City		PA		WW - Water	
Send results to: Patti Jannett			Project # 60276503				SW - Surface Water	
215-315-4325			Fax # 215-315-4151				SO - Soil	
Sampler(s) Name(s) (Printed)			Client Purchase Order #				SL - Sludge	
Sampler 1: Bill Kennedy							OI - Oil	
Sampler 2: dell...							LIQ - Other Liquid	
Accutest Sample #			DATE		TIME		LAB USE ONLY	
Field ID / Point of Collection			DATE		TIME		LAB USE ONLY	
HN-1075			4/14/15		1005		X	
HN-1075			4/14/15		1105		X	
HN-1075			4/14/15		1307		X	
HN-1075			4/14/15		1440		X	
HN-1075			4/14/15		1440		X	
HN-1075			4/14/15		1600		X	
HN-1085			4/17/15		1000		X	
HN-1085			4/17/15		1115		X	
FB-041715			4/17/15		1130		X	
Turnaround Time (Business days)			Data Deliverable Information		Comments / Remarks			
Std. 10 Business Days			Approved By: / Date/Rush Code:		Hard Copy of results			
7 Day RUSH			<input type="checkbox"/> COMMERCIAL "A" (RESULTS ONLY)					
5 Day RUSH			<input type="checkbox"/> COMMERCIAL "B" (RESULTS PLUS QC)					
3 Day EMERGENCY			<input type="checkbox"/> REDT1 (EPA LEVEL 3)					
2 Day EMERGENCY			<input type="checkbox"/> FULLT1 (EPA LEVEL 4)					
1 Day EMERGENCY			<input checked="" type="checkbox"/> EDD'S					
Other								
Emergency or Rush T/A Data Available VIA Email or Lablink								
Relinquished by Sampler/Affiliation			Date Time:		Received By/Affiliation		Date Time:	
Relinquished by Affiliation			Date Time:		Received By/Affiliation		Date Time:	

**ATTACHMENT 3**



Resolution Consultants  
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Chelmsford, MA 01824

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978.905.2101 fax

## Data Validation Report

Project: NAWC Warminster, PA

Laboratory: Accutest Laboratories

Job Numbers: FA23101

Analyses/Method: PFCs by Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS)/ EPA Method 537 modified

Validation Level: Limited

Resolution Consultants 60276503.SI.MS

Project Number:

Prepared by: Paula DiMattei/Resolution Consultants Completed on: 4/27/2015

Reviewed by: Lori Herberich /Resolution Consultants

File Name: Warminster FA23101\_PFCs

### SUMMARY

The samples listed below were collected by Resolution Consultants from the NAWC Warminster, PA site on March 23-24, 2015.

SDG	Sample ID*	Matrix/Sample Type
FA23101	S1-0.8_03232015	Soil
	S2-0.8_03232015	Soil
	S3-1.5_03232015	Soil
	S4-8.5_03232015	Soil
	S5-1.0_03232015	Soil
	S6-7_03242015	Soil
	S7-0.5_03242015	Soil
	S8-3_03242015	Soil
	S-DUP_03242015	Field duplicate of S7-0.5_03242015
	EB-032315	Equipment blank
	FB-032315	Field blank
	FB-032415	Field blank

\*The date of sample collection was appended to the sample ID in the project database in order to maintain unique sample IDs.

Data validation activities were conducted with reference to:

- Accutest Laboratories SOP: Analysis of Perfluorinated Alkyl Acids by LC/MS/MS; MS 014.1, Rev. Date: 05/14
- USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data review (USEPA, September 2011);

- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (June 2008);
- Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (DoD, October 2010); and
- the project-specific Sampling and Analysis Plan.

In the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

## REVIEW ELEMENTS

The data were evaluated based on the following review elements (where applicable to the method):

- ✓ Data completeness (chain-of-custody (COC)/sample integrity
- ✓ Holding times/sample preservation
- ✓ Initial calibration/initial and continuing calibration verification
- ✓ Laboratory method blanks/equipment blanks
- ✓ Surrogate recoveries
- ✓ Matrix spike (MS) and/or matrix spike duplicate (MSD) results
- ✓ Laboratory control sample (LCS) results
- ✓ Field duplicate results
- ✓ Internal standard results
- ✓ Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. The symbol (X) indicates that a QC nonconformance resulted in the qualification of data. Any QC nonconformance that resulted in the qualification of data is discussed below. In addition, nonconformances or other issues that were noted during validation, but did not result in qualification of data, may be discussed for informational purposes only.

The data appear valid as reported and may be used for decision making purposes. Qualification of the data was not required.

## RESULTS

### Data Completeness/Sample Integrity

The data package was reviewed and found to meet acceptance criteria for completeness:

- The COCs were reviewed for completeness of information relevant to the samples and requested analyses, and for signatures indicating transfer of sample custody.
- The laboratory sample login sheet(s) were reviewed for issues potentially affecting sample integrity, including the condition of sample containers upon receipt at the laboratory.
- Completeness of analyses was verified by comparing the reported results to the COC requests.



**Holding Times/Sample Preservation**

Sample preservation and preparation/analysis holding times were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

**Initial Calibration/Initial and Continuing Calibration Verification**

Calibration data were reviewed for conformance with the QC acceptance criteria to ensure that:

- the initial calibration (ICAL) percent relative standard deviation (%RSD) or correlation coefficient (r)/coefficient of determination ( $r^2$ ) method acceptance criteria were met;
- the initial calibration verification standard (ICV) percent recovery acceptance criteria were met; and
- the continuing calibration verification standard (CCV) frequency and method percent recovery criteria were met.

The QC acceptance criteria were met.

**Laboratory Method Blanks/Equipment Blanks**

Laboratory method blanks, field blanks and equipment rinsate blanks were evaluated as to whether there are contaminants detected above the detection limit (DL). Target compounds were not detected in the laboratory method blank, field blanks or equipment blanks associated with the samples in this data set.

**Surrogate Recoveries**

The surrogate recoveries (%Rs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met or qualification of the data was not required.

**MS/MSD Results**

The MS/MSD %Rs and relative percent differences (RPDs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

**LCS Results**

The LCS %Rs were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

**Field Duplicate Results**

Field duplicate RPDs were reviewed for conformance with the Resolution Consultants QC criteria of  $\leq 50\%$  for solid matrices. These criteria apply if both results were greater than five times the limit of quantitation (LOQ). All field duplicate precision criteria were met.

**Internal Standard Results**

The internal standard (IS) results were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

**Sample Results/Reporting Issues**

If applicable, compounds detected at concentrations less than the limit of quantitation (LOQ) but greater than the detection limit (DL) were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation.

**QUALIFICATION ACTIONS**

Qualification of the sample data was not required.



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## Data Validation Report

Project: NAWC Warminster, PA

Laboratory: Accutest Laboratories

Job Numbers: FA23700

Analyses/Method: PFCs by Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS)/ EPA Method 537 modified

Validation Level: Limited

Resolution Consultants 60276503.SI.MS

Project Number:

Prepared by: Paula DiMattei/Resolution Consultants Completed on: 5/8/2015

Reviewed by: Lori Herberich /Resolution Consultants

File Name: Warminster FA23700\_PFCs

### SUMMARY

The samples listed below were collected by Resolution Consultants from the NAWC Warminster, PA site on April 16-17, 2015.

SDG	Sample ID*	Matrix/Sample Type
FA23700	DUP-041615	Field duplicate of HN-109S_04162015
	FB-041615	Field blank
	FB-041715	Field blank
	HN-107I_04162015	Groundwater
	HN-107S_04162015	Groundwater
	HN-108I_04172015	Groundwater
	HN-108S_04172015	Groundwater
	HN-109I_04162015	Groundwater
	HN-109S_04162015	Groundwater
*The date of sample collection was appended to the sample ID in the project database in order to maintain unique sample IDs.		

Data validation activities were conducted with reference to:

- Accutest Laboratories SOP: Analysis of Perfluorinated Alkyl Acids by LC/MS/MS; MS 014.1, Rev. Date: 05/14
- USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data review (USEPA, September 2011);
- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (June 2008); and
- Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (DoD, October 2010); and

In the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

## REVIEW ELEMENTS

The data were evaluated based on the following review elements (where applicable to the method):

- ✓ Data completeness (chain-of-custody (COC)/sample integrity
- ✓ Holding times/sample preservation
- ✓ Initial calibration/initial and continuing calibration verification
- ✓ Laboratory method blanks/equipment blanks
- ✓ Surrogate recoveries
- ✓ Matrix spike (MS) and/or matrix spike duplicate (MSD) results
- ✓ Laboratory control sample (LCS) results
- ✓ Field duplicate results
- ✓ Internal standard results
- ✓ Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. The symbol (X) indicates that a QC nonconformance resulted in the qualification of data. Any QC nonconformance that resulted in the qualification of data is discussed below. In addition, nonconformances or other issues that were noted during validation, but did not result in qualification of data, may be discussed for informational purposes only.

The data appear valid as reported and may be used for decision making purposes. Qualification of the data was not required.

## RESULTS

### Data Completeness/Sample Integrity

The data package was reviewed and found to meet acceptance criteria for completeness:

- The COCs were reviewed for completeness of information relevant to the samples and requested analyses, and for signatures indicating transfer of sample custody.
- The laboratory sample login sheet(s) were reviewed for issues potentially affecting sample integrity, including the condition of sample containers upon receipt at the laboratory.
- Completeness of analyses was verified by comparing the reported results to the COC requests.

### **Holding Times/Sample Preservation**

Sample preservation and preparation/analysis holding times were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met or qualification of the data was not required.

### **Initial Calibration/Initial and Continuing Calibration Verification**

Calibration data were reviewed for conformance with the QC acceptance criteria to ensure that:

- the initial calibration (ICAL) percent relative standard deviation (%RSD) or correlation coefficient (r)/coefficient of determination ( $r^2$ ) method acceptance criteria were met;
- the initial calibration verification standard (ICV) percent recovery acceptance criteria were met; and
- the continuing calibration verification standard (CCV) frequency and method percent recovery criteria were met.

The QC acceptance criteria were met.

### **Laboratory Method Blanks/Equipment Blanks**

Laboratory method blanks and field blanks are evaluated as to whether there are contaminants detected above the detection limit (DL). Target compounds were not detected in the field blanks associated with the samples in this data set.

The method blank associated with samples HN-107S, HN-107I, HN-109S, HN-109I, DUP-041615 and FB-041615 contained Perfluorohexanesulfonic Acid (PFHxS) [0.00863 J  $\mu\text{g/L}$ ] and Perfluorooctanesulfonic Acid (PFOS) [0.102  $\mu\text{g/L}$ ]. Since the PFOS amount in the method blank exceeded the reporting limit (RL), re-extraction of all associated samples was performed with two exceptions: 1) Sample HN-107S was not re-extracted because there was insufficient sample volume available for re-extraction and 2) The field blank FB-041615 was not re-extracted since no target compounds were detected in this blank. However, it should be noted that the re-extraction was performed outside of the 14-day extraction holding time criterion.

Although the method blank associated with the re-extraction batch was free from contamination, professional judgement was used to report the original analyses which were performed within holding time and without qualification since the method blank contamination in the original batch appears to be an anomaly. The sample results in the re-extraction/reanalysis were similar to the original analyses of these samples and the field blank (FB-041615) prepared in the original batch was free from contamination.

### **Surrogate Recoveries**

The surrogate recoveries (%Rs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met or qualification of the data was not required.

### **MS/MSD Results**

The MS/MSD %Rs and relative percent differences (RPDs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.



**LCS Results**

The LCS %Rs were reviewed for conformance. All QC acceptance criteria were met.

**Field Duplicate Results**

Field duplicate RPDs were reviewed for conformance with the Resolution Consultants QC criterion of  $\leq 30\%$  for aqueous matrices. This criterion applies if both results were greater than five times the limit of quantitation (LOQ). All field duplicate precision criteria were met.

**Internal Standard Results**

The internal standard (IS) results were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

**Sample Results/Reporting Issues**

If applicable, compounds detected at concentrations less than the limit of quantitation (LOQ) but greater than the detection limit (DL) were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation.

**QUALIFICATION ACTIONS**

Qualification of the sample data was not required.